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AUTHOR Bell, Paul E.
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ABSTRACT

This paper discusses four conceptions of excellence (excellence as proficiency, excellence and disciplinary initiation, excellence as self-actualization, and excellence as social responsibility) and shows how they can be addressed within a science, technology, society (STS) approach to science instruction. Additional topics considered include: (1) the nature of the STS approach (which selects content according to students' experience rather than following the so-called "natural" topics identified in textbooks); (2) how STS instruction might work; (3) training teachers for STS instruction; (4) whether teachers can really learn to teach STS (listing nine requirements for STS teaching); (5) STS training programs; (6) teacher capabilities; and (7) the availability of STS workshops. The preliminary analysis of the characteristics of training necessary for STS teaching, the qualities of suppleness and receptivity in exploring new integrative forms of teaching, and the multiplicity of potential topics that might be generated from technological development all portend a bright and interesting future for STS, locally-born and nurtured in various school districts. This approach, and its special attributes also could lead to important changes in the form and function of inservice training and staff development of teachers toward building better science instruction. (JN)

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Staff Development Models Using The STS Approach for Content Renewal*

Paul E. Bell, Associate Professor of Education
The Pennsylvania State University

Introduction

Declining enrollments in secondary schools, student reluctance to take more science and mathematics than necessary to meet high school graduation or college entrance requirements, and reduced teacher mobility have placed secondary school faculty in the position of having to teach science and mathematics courses for which they are either unprepared or for which their preparation and experience are outdated. The public now calls for excellence, because our nation is at risk. (Gardner, 1983).

What is Excellence?

"I find," John Gardner (1984) writes, "that 'excellence' is a curiously powerful word--a word about which people feel strongly and deeply. But it is a word that means different things to different people." Like so many concepts, "excellence" is a concept whose meaning and range of application to cases are contested. Prakash and Waks (1985a) found four conceptions of excellence as they reviewed the several reports and commission statements calling for educational improvement.

The four conceptions of excellence are generated by the ways of thinking, the aspirations, and the hopes of different groups of Americans, each with their interests to be served, issues to be raised, and questions to be answered. Each conception has had to come to terms with the most fundamental issues of education, such as: the meaning and purpose of education, desirable forms of knowledge and understanding,

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theories of mind and learning, appropriate curricula, effective forms of student-teacher interactions, individual development, intelligence, giftedness and creativity, evaluation of student performance, educational leadership, educational research, teacher training and assessment, and desirable educational reforms, among others.

Conception One: Excellence As Proficiency (E-1)

The first conception of excellence--excellence as proficiency (E-1)--is organized around the image of education as rational production, as the efficient adjustment of productive means to determinate, measurable ends. Typically these ends are cognitive competencies, units of knowledge and mental skill measured by standardized or other objective tests. Standards of value are quantitative; excellence is proficiency in the sense of exemplary test scores.

In this framework, the mind is seen in its more mechanical dimensions; there is an emphasis on memory of information; understanding is viewed as the ability to subsume problems under standard problems types and to apply the appropriate problem-solving routines.

Typical learning activities include the rote acquisition of information (e.g., state capitals, and biological species) and the mastery of cognitive routines (e.g., drill in basic skills and the application of arithmetical or scientific formulae). Textbooks and computer assisted media concentrate on information and on <u>standard</u> problem types.

Teachers are conceived as information providers and as trainers in skills and problem-solving routines. A student whose teacher always has the standardized achievement test in mind, and exclusively gears instruction to the information and standard problems to be encountered there, will on average score better on such tests than the student whose teacher promotes learning as an intellectual "adventure." The latter sort of teacher will be regarded as failing to promote excellence.

Adherents of this conception tend to distrust teachers, and seek to restrict their autonomy in lesson planning, instruction, or student evaluation. Teacher-proof curricula and instructional media are recommended where possible. Standardized tests of achievement are perceived as fair and objectives means for holding teachers accountable for achieving excellence conceived in this way.

Educational leaders are conceived as managers, supervising teachers who are the providers of knowledge and skill. The manager's first task is to keep the school running efficiently, sorting out unproductive teachers and handling the concerns of parents and other community members, reframing these concerns in terms of competencies, productive efficiency, and test scores.

Conception Two: Excellence as Disciplinary Initiation (E-2)

The disciplinary initiation conception of excellence is shaped by a view of knowledge and understanding as inherently social or intersubjective, as taking place in institutional contexts (e.g., the community of scientists, the art world) in which individuals contribute to an on-going evolution of ideas and standards. The purpose of education is to involve young members of society in these worthwhile forms of rule-governed activity by transmitting current working conventions and standards of value in a variety of disciplines.

Education is thus the cognitive socialization of the young, justified as central to the development of humanness. Proponents of this conception see attainment of "the good life," or "self-actualization," or other terms for excellence as inextricably connected with the ability to understand and appreciate the world from a variety of disciplinary perspectives (e.g., the scientific, the aesthetic, and the moral.) Human excellence is viewed as significant participation in the adventure of mind, the evolution of these forms of thought. Excellence in education is attained as the skills, habits, and attitudes are learned which promote the full participation in and contribution to this dynamic process of evolution. Educational excellence on this view is synonymous with initiation.

The initiation standard of excellence emphasizes disciplined thinking, where validity is determined by institutional norms in evolution. What is valid in scientific thinking is shaped by currently accepted paradigms; the same logic holds for the humanities and for the fine arts, shaped by the art world context.

On this conception, teaching involves the presentation of evolving ideas and concepts in a rational manner typical of the discipline. Teaching consists primarily of intellectual acts exemplary of the field of study. Typical learning activities include not only lecture discussion aimed at the growth of understanding, but projects in science, the humanities, and in interdisciplinary studies after the respective styles of study used by the practitioners in the disciplines. Students are presented with conceptual units which stretch their understanding, extend their grasp on the forms of thought, excite their curiosity, and build their values. The goal is not primarily to instruct, but to build up a mass of patterned responses for subsequent testing.

Teacher preparation is conceived primarily as training, to the level of mastery, in the disciplines. Teachers-in-training are directed to devote themselves to studies in the sciences, the humanities, and the fine arts, with studies in curriculum, instructional methods, and educational psychology receiving considerably less attention.

Educational leadership on this view is the masterful orchestration of teacher-learning activities by a master scholar-teacher. Leaders protect the intellectual and artistic life of their institutions from the challenge of hostile or misinformed community members and over-anxious parents.

Conception Three: Excellence as Self-Actualization (E-3)

The third conception of excellence (E-3) is shaped by a vision of the individual being in a lifelong quest for authenticity and freedom from both biological and social conditioning. Self-actualization is the end of human development and hence

the organizing principle and standard of excellence for this conception. Each individual must shape the development of his or her unique mind, and integrate mental and other powers in the pursuit of cognitive and other personal ends to actualize him or her self.

In teacher preparation, the advocates of the self-actualization conception of excellence emphasize training for self-awareness and personal growth. By coming to understand their own limitations, emotional reactions, and temperamental biases, teachers-in-training appreciate better the role of projections and distortions in their own perception and judgment, and hence learn to relate to their pupils as independent persons.

On this conception, the educational leader is the learned sage, who understands the limits of helping and meddling, and is able silently to witness students and staff members alike making errors in judgment and learning hard lessons, trusting that errors will be made, and understanding that nothing really worth knowing can be learned in any other way.

Conception Four: Excellence as Social Responsibility (E-4)

The social conception of excellence extends its concerns beyond the individual to the community; it places the satisfaction of individual ends in the context of the community of ends. Far from wishing to stifle individual self-actualization for the sake of "society," this conception sees self-actualization as of cardinal importance. As Fred M. Newman and Donald W. Oliver (1967) put it, "We assume that the most fundamental objective of education is the development of individual human dignity, or self-actualization within community." This objective urges a conception of self-actualization in which each person's good depends on the common good, and it refuses to let the good of any member of society be sacrificed for the self-actualization of another. The goal of education is the actualized individual in the just society, and this requires a particular form of actualization, governed by a

principle of active concern and responsibility for the common good. Social responsibility sets the standard of educational excellence.

Proponents of the fourth conception of excellence demand that schools aim at the development of such intellectual and practical excellences as: (1) the ability to interpret a complex social or interpersonal situation, identifying the problem and generating suitable options for its solution; (2) practical know-how in creating and managing the human and material resources involved in the solution; and (3) the heart, motivation, courage or strength to act—to do what must be done to serve the common good.

Proponents of the social responsibility conception seek to "open up the schools." Acknowledging the contributions of professional educators, they state that many non-certified but public-spirited individuals would be better role models and better teachers of the young. Where professional teachers are involved, their training must emphasize social action.

Similarly, advocates note that standard school problems are not the most effective challenges for developing skills and attitudes of public responsibility, and they call for a curriculum of genuine, "real life" problems. As Newman and Oliver state, "Significant problems. . .emanate not from R and D laboratories. . .but from strains and dilemmas in the world beyond school walls."

In this conception, the educational leader identifies authentic problems and inconsistencies deriving from students' life experiences, and help students locate and seek out community resources to shed light or add confusion to the issue under study. The leader also encourages teachers, and their students, to reflect on their learnings and make decisions regarding appropriate actions on behalf of the greater good of the community, including the decision to withhold action. The leader develops opportunities for learners to take stands, individually or collectively, and defend decision, mutable with new information, which may or may not agree with his or her own opinions.

Each of the four conceptions is supported by one or more recommendations offered in the several positions (Gardner, 1984; Coleman and Selby, 1983; Gardner, 1983; Hueftle, et al., 1983; Hunt, 1983; Mondale, 1983; National Science Foundations, 1979; National Science Foundation, 1983; Pennick, 1983; Pennick & Yager, 1983; UNESCO, 1983). Each conception builds on but is not totally compatible with the previous conception.

How Can the Four Conceptions of Excellence Be Addressed?

It is clear that elements from typical science instruction and the movements for change advanced in the last decade are necessary but insufficient. The assumption of what's good for one learner is good for all learners, apparent in previous approaches is incongruous with what is known about learning as compared with the nation's need.

Although complete agreement about the details of literacy are elusive, two components emerge in most definitions. The first is related to improving the scientific and technological thinking and problem-solving skills of <u>all</u> learners regardless of occupational destination. This goal is not new, for it prevailed as an insistent theme among the curricula developed in the post-Sputnik era. However, the benefits of that effort resided primarily among those students bound for professional careers in science related fields. The new clarion calls forth similar benefits for the broad spectrum of learners finding their way through our schools.

The second component provides for understanding science and technological learnings to be <u>used</u> by the learner, and has personal, political and economic dimensions. It involves providing individuals the scientific and technological understandings and skills appropriate for solving personal problems in such areas as health and nutrition. It also means assisting individuals to make intelligent career choices, and helping learners headed for non-scientific careers in human services, management, sales, marketing, communications and production to understand the

products and processes related to their work. These products and processes are strongly influenced by technological developments and new science understandings which can and should be nurtured during schooling. Politically, it means promoting the use of scientific and technological understanding in solving problems, making value judgments and developing social action skills so that individuals and groups may participate effectively as decision-making citizens in our technological democracy.

Although social and political dimensions of science and technology have received some attention in past science curricula, these dimensions are now being promoted to central importance as an organizing core around which the traditional subjects cluster to comprise the curriculum. This is a dramatic change in the goal for science education, formed in response to pressing needs arising in our era (Miller, 1983). Most citizens, indeed most leaders, feel incompetent to participate in democratic decision-making about technological problems, programs or policies. Few are able to understand the thinking used by expert decision-makers who in turn rely upon scientific and engineering concepts and tools (Miller, Prewitt, and Pearson, 1980; Prewitt, 1983).

Two dimensions of instruction are called upon to achieve scientific literacy: (1) the integration of knowledge, concepts and procedures from many intellectual disciplines, and (2) the direct study of the influence of society on science and technology and the resulting impacts by the emerging technology on society. The description from the guidebook, Science and Technology Education and National Development (UNESCO, 1983) is in full agreement with these dimensions;

> Technology education should be based on real community interests, and concerns related to the use of technology. The overriding content questions should be what is and what ought to be the role of technology in this community? Technologies can cause

problems and they can be used to solve problems. In either case, technology education should stem from an effort to deal with those actual problems that somehow implicate technology.

This different approach has been designated by the NSTA as the Science, Technology and Society (STS) approach, and serious efforts have begun to prepare teachers to use this approach in their science instruction.

STS as a focus for instruction requires the different forms of excellence found in the four conceptions. Clearly, the impetus for learning lies in personal experience and fulfillment found in conception E-3 and the broad community concern of conception E-4. However, the legitimacy of inquiring and knowing through lenses of several pertinent disciplines, including the respective conventions, standards, logic bass, accumulation of history and other heuristics, is the hallmark of study offered by conception E-2. Proficiencies championed by proponents of conception E-1 will come through practicing skills needed for the types of excellence in learning identified in the context of the other three conceptions.

What is the STS Approach?

The STS approach selects content according to students' experience rather than following the so-called "natural" topics identified in textbooks. For example, the physics and biology in textbooks rarely cross the other's boundaries, whereas in human experience they merge frequently. For instance, flickers from fluorescent light interacting with different frequencies of flickers from the CRT of a word processor cause headaches. Electromagnetic wave emissions by the chemical properties of phosphors derived from minerals regularly affect electrochemical responses in biological systems, and thereby cause discomfort if not dysfunctions. Continued exposure to these results of technology is pressed by public and corporate expectations as a condition of work necessary to beat the competition. Regardless of the physiological stress, the employees as part of the general public benefit from

these technologies. Thus technological advances integrate the several sciences, and interact with social pressures and personal welfare.

The STS approach teaches science and mathematics concepts inherent in and related to issues and questions for which answers of rightness or wrongness are elusive, but which are authentic and vital problems demanding insights from studies of science through relating science, technology, and society. STS issues are given instructional priority according to the extent of human concern raised by the issue and the applicability of the principles involved in the issues to other human experiences. Topics to be studied are selected from the news media; textbooks join libraries, the media and local professionals as sources supplying authentic, detailed information from which students may make decisions about the veracity of claims and new understandings. STS is taught with the intent that learners will practice making informed decisions, based on study of contemporary information from relevant disciplines, about courses of action which they will support or implement.

How Might STS Instruction Work?

Suppose biology students selected an article on running shoes from a recent issue of High Technology (Tucker, 1985). The first step of identifying a science subject from students' personal experience has been accomplished through this ubiquitous type of footwear. The article leads students through discussion of two terms, "overpronation and oversupination," to engage in thinking about anatomical orientation concepts used by health practitioners. Moreover, operational definitions based on ankle measurements comparing foot axis to leg axis add to acceptance and understanding of quantification.

Reading further the student learns that weight, size of hips, speed, shape of the leg, and running habits of the wearer dictate one of two general types of shoes, straight last or curved last. Now the student needs data on his or her own running, easily estimated by using videotape and simple measurements. The student is then

ready to explore possible brands and models that might meet his or her needs determined empirically. Various approaches to running shoe design are compared. Does the reader need more information? The periodical refers the reader to the addresses of eleven running shoe manufacturers and four additional articles.

However, the research thus far, leading to customized running shoes costing $140 per pair, has been based only on men's running. Aha, a new social issue, and a possible vocation in research are identified! Women's running mechanics have not been investigated, and the application of automation in this labor intensive industry has barely begun.

Perhaps the running shoe example sits less well than others. For instance, artificial intelligence is fascinating and a contemporary topic in the March issues of both Science 85 (Waldrop, 1985; Rose, 1985) and High Technology (Kinnercan, 1985; Linden, 1985), or nuclear energy is still a frequent theme in a variety of media (DeYoung, 1985).

The running shoe example illustrates the possibility of teaching students hard core science that goes well beyond fact recall and step-by-step story problems which typically comprise the menu of textbook teaching. Students are led from their own experience, through science, to technology, probably through more science, to awareness of some social or personal consequences of the current way things are done, and toward decisions about personal and social action. But what teacher ever studied running shoe construction in biology, physical education, physics, or chemistry?

How Can Teachers Be Trained for STS?

In a review of research on environmental education Rubba and Wiesenmayer (1985) have identified four factors which lead to citizens' working toward achievement and maintenance of dynamic equilibrium between quality of life and quality of environment:

1. Knowledge of ecological foundations.
2. Conceptual awareness of environmental issues and the values underlying the respective positions.
3. Experience investigating and evaluating alternative solutions.
4. Training in action skills and applications.

If environmental education is a sub-set of STS, those steps appropriate across the spectrum of environmental issues should also apply across the issues of STS. Closer examination of the first factor suggests that two levels of knowledge are called for: (a) knowledge of the foundation concepts from the sciences, social sciences, history or philosophy pertinent to the issue, and (b) understanding that integrates the several foundational concepts, facts, principles, conventions, and approaches. Contemporary schooling is weak in providing the integrational level of experience.

Factor two identifies problems in which conflicting views carry different sets of values. This level builds perspective through analysis of the histories and philosophies attendant to the various positions on an issue.

The third factor also has two levels: (a) development of problem investigating and problem evaluating skills and standards, and (b) development of skills in applying those skills together in assessing a particular STS issue. This level brings the investigator face-to-face with the interactions of science and social science methodologies with technological methodologies.

The fourth factor calls for three levels of action: (a) the student must sort his/her own values, which will influence the other two levels of action; (b) the learner must select specific activities to be taken or supported as opportunities present themselves in one or more of five categories of action: informed consumerism, persuasion, political action, physical action and legal action; and (c) the student must decide whether to engage in group action within class, within school, or beyond school.

If teachers are to use the STS approach, they must be willing to seek issues related to students' life experiences, locate and enlist the help of resource persons, identify contemporary, authentic print and non-print resource materials, and weave these elements into an instructional plan. Teachers must have tolerance for the unexpected, unfinished, and non-traditional. They must have confidence in the notion that learning can occur during problem-solving without requiring a huge backlog of pre-requisite learning or courses. Teachers must see themselves as fellow learners with their students rather than as founts of knowledge.

Can Teachers Really Learn to Teach STS?

A large body of research suggests that teachers function at concrete level most of the time; they have to learn by experience. Typically in workshops, teachers walk through student activities and are assumed to perform with fidelity those same actions for or with their own students. Teacher-proofing curricula has been shown to be a non-existent accomplishment, for teachers always adapt materials or approaches. Therefore, teachers, responding to experiences but not being completely dependent upon them, will be able to meet the conditions necessary for STS if training can meet several requirements:

1. Teachers, as do younger learners, function best in a supportive climate in which positive reinforcements are frequently presented, and in which their productivity is successful. Teachers, like many other adults who assume that they should be nearly perfect, feel vulnerable and tend to avoid risk. Consequently, supportive climate during risk-taking is very important and rarely addressed in adult learning situations.
2. Teachers rate instruction as being more valuable if they have helped decide what should be learned and have had a part in selecting the style of instruction. Usually, they select as beneficial those instructional formats which are viewed as practical. Practicality is directly related

to the degree to which information or skills learned and materials used or produced in the workshop may be used, without modification, for teaching their own students.

3. Teachers bring with them a sense of pride that they know how to teach well and expect the instruction to be limited to new information or content related skills. This is a ticklish situation because promoters of new curricula tend to view appropriate instructional approaches as a highly important component of the curriculum. Teachers perform better if their leaders model the preferred approach.
4. Teachers perform still better if they have analyzed the modeled approach against a set of criteria.
5. Teachers need rehearsal in doing the tasks that are necessary to meet the demands of an approach. STS is definitely not accommodated by didactic teaching.
6. Teachers need to take with them the instructional materials to be used in the desired approach.
7. A new approach is more likely to be implemented if three or more teachers in the same school are committed and trained to use the approach.
8. Student performance is also enhanced if their teachers teach toward the same goals which are promoted and supported by the building principal.
9. Long-range impact is likely to be higher if periodic on-site assessments and exchanges between teachers using the approach are held during the school year.

These nine conditions can be met relatively easily with STS. The factors identified for students in Figure I also pertain to teachers. If teachers draw from

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Figure 1 About Here

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life experiences to identify STS issues, then, using resources available, go on a treasure hunt to gain the perspectives, skills, and knowledges necessary for decisions, they will be deciding the content (condition # 2) and modeling the approach (condition # 3). They can easily critique each other's approaches, and even provide rehearsal feedback (conditions # 4 & 5) while they develop materials appropriate for their students (condition # 6). Since STS is interdisciplinary, obtaining a critical mass of interested teachers is likely (condition # 7). The wide variety of contemporary social issues bearing on science and technology makes likely the addition of other interested persons until most teachers are reinforcing higher levels of thinking (condition # 8). Frequent sharings of exciting topics, strategies, materials, and learning accomplishments will comprise an ongoing formative evaluation (condition # 9).

This portrayal of liklihood is speculative to be sure, and it certainly flies in the face of current models of inservice which tend to confirm anticipations of teacher deficiencies and unwillingness. Will teachers really respond positively to expectations of creativity and resourcefulness when they are not specifically trained, and indeed are viewed as being deficient in the sciences?

Self-Starters in STS

First of all, it is gratifying to know that over 2000 teachers have identified themselves for Penn State's national STS network. A large number of these teachers have been promoting STS for some time and have formed their own consortia of interested persons. Each time an STS presentation is made, additional persons, not knowing of other efforts, identify themselves. This independent emergence of

teachers oriented to STS thinking suggests that a number of teachers can effectively prepare themselves without highly structured inservice. Moreover, it suggests the basic worth of STS as a goal because good ideas arise from a number of sources independently. Some of the thinking may be sampled in Curriculum Review, Jarcho, 1985; Penick, 1985; Switala, 1985).

Imposing STS on a Capivated Audience

The acceptance of initiative by STS inclined teachers is one thing; captivating the non-STS-prone teacher may be another. In November, 1984 a captive group of 32 hard core science teachers, sponsors of Pennsylvania Junior Science and Humanities Symposium's outstanding students, were brought together to map out instructional modules on Energy, Unemployment, Economics, and Environment. They had received advanced mailings of articles promoting and describing STS and sample STS college modules on a different STS issue.

Some of the teachers read the shorter articles in the advanced mailing; only one had read all the material. Teachers were apprehensive and reluctant at first, but by the end of the first 90 minute session, started to warm to the idea of being resources instead of being "trained." In the remaining 2 1/2 hour period their small groups generated well organized outlines of the topics to be addressed and included some references for student use. Debriefing discussion indicated that the STS approach required some shift in their thinking, but was attractive and gratifying. They also indicated an improvement in their feelings of adequacy in science and a more positive feeling about working in interdisciplinary fashion with other teachers on topics clearly having scope beyond the expertise of any one of them.

Walk-ins

Later in November at the Southeast Regional NSTA Conference at Charlotte, N.C. a two-hour workshop was listed for a late afternoon spot in the program. Sixteen persons participated, one left after learning of the nature of the activity.

No advanced reading material or resource material was used. They were given a brief description of the STS approach and an outline of the task to create modules for the same topic, Energy, Unemployment, Economics, and Environment. These teachers represented elementary, middle, junior high and senior high school assignments from all the sciences in both private and public schools.

The topic was not as critical an issue in North Carolina as it had been in Pennsylvania, largely because unemployment was a less universal and intense problem. Debriefing disclosed that the feeling of being a resource was an entirely unexpected and pleasant change. Moreover, participants were surprised to learn that they actually could contribute to the task productively regardless of the grade level or subject which they taught. They encouraged more "curriculum development" opportunities at national and regional workshops.

Short Course

At this NSTA Convention a short course in STS on the topic of microcomputers was offered as a late listing. There were zero registrations. We think that the topic may have been inappropriate or poorly titled, that teachers may be too insecure in their stage of development with computers to tackle them as issues, they may not have seen the announcement in the advanced program, or they may not have wanted to or been able to get released for an all-day short course.

Modules From Presentations by Prominent Speakers

The invited speakers for a January Conference on Health and Healing at Penn State were matched with graduate student teams comprised of teachers and community health service professionals. The graduate students attended presentations, held additional interviews with their respective speakers, and studied other works by the speakers. During the spring semester the team of four teachers, from the fields of biology, elementary science, English and social studies, with their four community health service counterparts are writing an STS primer on "Health

Services and You" for use by students, grades 9-12. The work will be made available to interested secondary school teachers next fall, and will feature free reproduction rights.

This approach has shown that the teachers (now graduate students) are very capable in understanding technical presentations and technical publications despite their own training. The interaction between the teachers and their colleagues from health fields has been mutually stimulating and productive. This may be one of the most promising forms of staff development for STS instruction.

Observations About Teacher Capabilities

Although the national image of teachers' abilities to teach science is not very positive, we are encouraged that they do have the capability and desire to learn for themselves the scientific and technological information necessary to teach science through STS in a meaningful fashion. We suspect that three kinds of promptings are desirable from outside "experts." The first is the need for fresh input from researchers in science and technology fields. The second is strong and persisting encouragement (similar to those varied tactics used by coaches in athletics, speech contests, band contests, and theatrical events) that they can indeed build excellent instructional materials. Part of the incentive for excellence is the knowledge that their materials should be polished sufficiently for sharing with teachers unknown to them across the U.S. This writing for others is the third type of supervision and encouragement needed to exact more precision than day-to-day teaching usually demands.

Consistently, research tells us that teachers use materials they produce or adapt, that teacher generated materials are preferred over those developed by college faculty or industry, and that working as a team on materials is both more satisfying and viewed as producing more creditable work than solo effort. STS offers these opportunities for staff development through materials generation. This

approach to staff development is not a reinventing of the wheel because good instructional materials are relatively unavailable. They are non-existent in science or social science textbooks.

Are STS Workshops Available?

As yet we have not surveyed the nation to determine the availability of STS workshops. However, the following are known through informal communications

1. ASCD is offering a National Curriculum Study Institute entitled The Changing Science Curriculum: Science, Technology, and Society, April 16-17, 1985 in Alexandria, Virginia.
2. University of Iowa is cosponsoring the Second Exeter Conference on STS, June 16-22, 1985. This conference is invitational. Contact Robert Yager, 319/353-3600.
3. Penn State is offering a three-week workshop, July 1-19, 1985, tuition for which is assumed by the Pennsylvania Higher Education Assistance Agency. This workshop is for middle, junior high and senior high school teachers within commuting distance of University Park, Pennsylvania.

   Contact: Dr. Peter A. Rubba
   178 Chambers Building
   University Park, PA 16802
   814/865-2430
4. University of Iowa is conducting an STS Honors Workshop for Teachers, July 21-August 3, 1985. NSF is funding participation by 30 teachers; others are invited to attend at their own expense. Contact Robert Yager, 319/353-3600.
5. Lehigh University (Pennsylvania) is planning a Technology Studies Resource Center Colloquium in the fall of 1985. Contact Stephen Cutcliff, 215/861-3349.

6. Baltimore City Schools will be conducting an STS curriculum writing summer workshop during 1986 for invited teachers. Information may be obtained from:

Bill Williams
164 Chambers Building
University Park, PA 16802
814/865-2161

Summary

The preliminary analysis of the characteristics of training necessary for STS teaching, the qualities of suppleness and receptivity in exploring new integrative forms of teaching, and the multiplicity of potential topics that might be generated from technological developments all portend a bright and interesting future for STS, locally born and nurtured in the various school districts. This approach, and its special attributes also could lead to important changes in the form and function of inservice training and staff development of teachers toward building better science instruction.

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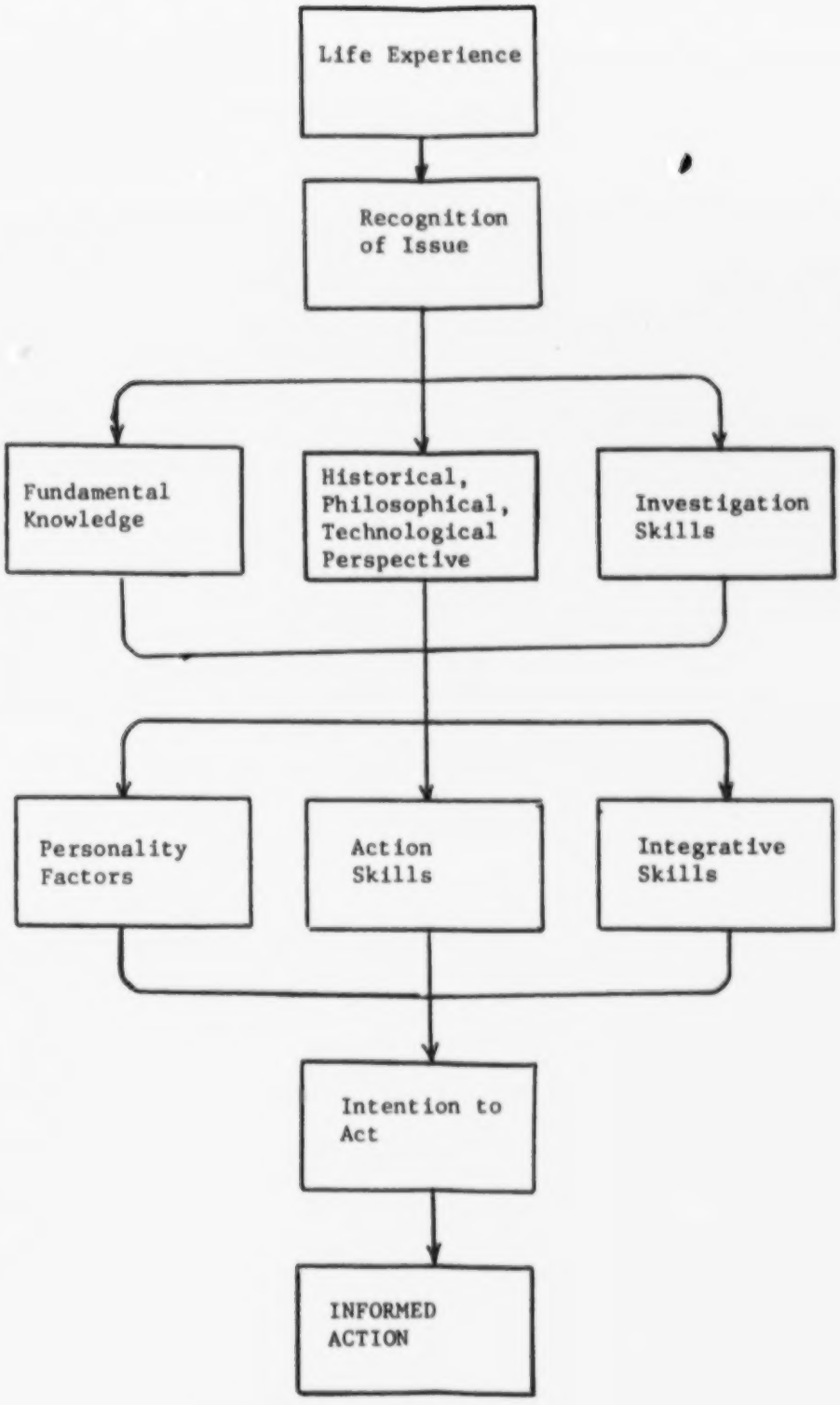

Figure 1. Factors Leading to Informed Action on an STS Issue (Adapted from Hines, 1984).